

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey
of
Randolph County, Indiana

By

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Management of the Soils
of Randolph County

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SOIL SURVEY OF RANDOLPH COUNTY, INDIANA

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COUNTY SURVEYED

Randolph County lies along the central part of the eastern boundary of Indiana (fig. 1). It is approximately square and comprises an area of 447 square miles, or 286,080 acres. Winchester, the county seat, is about 80 miles northeast of Indianapolis, the State capital.

This county lies within the region of the late Wisconsin glacial drift. Over most of its area the surface relief is that of a plain which presents few physiographic features other than swells and sags, with differences in elevation, in most places, of not more than 10 feet. Along the northern side is a belt of slightly uneven surface relief called the Mississinewa moraine which follows the course of Mississinewa River on the north. Another morainic belt, called the Union City moraine, extends east and west across the middle of the county. In the eastern part this morainic belt is comparable to that of the Mississinewa moraine, but in the middle and western parts it is lower and becomes nearly indistinct. A part of the Bloomington morainic system crosses the southwestern corner of the county. This terminal moraine is not so conspicuous as the others, but in a few places low mounds and flattened ridges stand out rather prominently. The thickness of the drift differs somewhat in different sections, but in only a few small areas is the drift so thin that the underlying rock material has an influence on the soil material.

The range in elevation is comparatively slight. Winchester lies 1,097 feet above sea level.¹ The highest elevation in the State (1,285 feet) is within this county, about 3 miles east of Lynn.

Here and there low mounds and nearly flat ridges stand out rather prominently. The most undulating surface relief is confined to those parts of the county occupied by terminal moraines. The greatest local difference of elevation is in the southwestern part where the streams and valleys are more deeply cut, but even here the streams and valleys do not form gorges or cause a rough surface relief, as the valleys are not steep walled but have gently sloping sides. In many places on the broad divides the streams and the small valleys are in-



FIGURE 1.—Sketch map showing location of Randolph County, Ind.

¹ LOGAN, W. N., CUMINGS, E. R., MALOTT, C. A., VISHER, S. S., TUCKER, W. M., and REEVES, J. R. HANDBOOK OF INDIANA GEOLOGY. Ind. Dept. Conserv. Pub. 21, 1,120 pp., illus. 1922.

distinct, and the stream channels are only slightly lower than the upland. Terraces occur in the larger and more distinct valleys and along Mississinewa and White Rivers, but in most places the terraces merge into the uplands with slight differences in elevation and with gradual slopes.

Most of the streams, except Mississinewa River, rise within the county. White River, which flows west, drains all the southern part, with the exception of a few sections in the southern and eastern parts where the watershed slopes toward Whitewater River in Wayne County and toward Stillwater River in Ohio. Mississinewa River crosses the northern part of the county, flowing parallel to and within 2 miles of the northern county line. Most of the tributary streams flow in a northerly direction, and the divide separating the drainage systems of Mississinewa and White Rivers in most places is within a mile of White River. In many places, especially in the old glacial channels and troughlike valleys, it is difficult to distinguish the divide between the watersheds.

Randolph County has good transportation facilities. The main line of the Cleveland, Cincinnati, Chicago & St. Louis Railway crosses the central part, east and west through Winchester and Union City. The Pennsylvania Railroad runs diagonally across the northern part from Union City to Chicago, and a branch line of the Pennsylvania enters the county south of Lynn, passes through Winchester, and leaves north of Ridgeville. A branch line of the Chesapeake & Ohio Railway crosses the southwestern corner, and a branch line of the Cleveland, Cincinnati, Chicago & St. Louis Railway crosses the southern part, east and west through Lynn.

United States Highway No. 27, a hard-surfaced road, crosses the center of the county from north to south, passing through Deerfield, Winchester, and Lynn; United States Highway No. 36 traverses the southern part, passing through Modoc and Lynn; and State Highway No. 32 runs from east to west through Parker, Farmland, Winchester, and Union City. Very nearly all the public roads are hard or gravel surfaced.

The native vegetation belongs to the oak-hickory forest association. At one time a forest growth covered the whole county, but at present the trees are confined to wood lots and to narrow strips of land along the larger streams. The original tree growth included shellbark hickory, red oak, sugar maple, black ash, and black walnut. Shrubs and vines consist largely of wild cherry, bittersweet, sumac, blackberry, and wild grape. Papaw, sycamore, tuliptree, and elm grow in the poorly drained areas and bottom lands. Most of the grass is bluegrass which is an introduced species.

Of a total population of 24,859 in 1930, 17,288 people are classed as rural. The density of the rural population in that year was 38.7 persons a square mile. Winchester, the largest town and county seat, has 4,487 inhabitants.

CLIMATE

The climate of Randolph County is humid, temperate, and continental. The temperature and rainfall vary somewhat from year to year, and frequently changes of temperature are sudden. Damage to crops by early or late frosts occur at times, but little damage is done

to general-farm crops. During the corn-growing season temperatures are generally high, and the rate of evaporation is relatively high. The corn crop is sometimes damaged by drought. Disastrous failure of all crops is unknown.

The rainfall is generally well distributed for agriculture, with 57 percent of the average annual precipitation of 38.77 inches occurring in the warm season (April to September, inclusive). In less than 10 percent of the years is the warm-season rainfall reduced below three-fourths of the average.

The climate is such as to favor the production of crops of sufficient variety to maintain a well-balanced, diversified, and permanent agriculture.

Weather conditions which are unfavorable for one crop often favor another; for example, cool, wet springs, which may delay the planting and hinder the early growth of corn, favor the growth of bluegrass, the principal pasture grass. This county is comparatively free from serious and widespread damage by high winds, hail, or lightning.

The average dates of the earliest and latest killing frosts at Farmland are October 13 and April 28, respectively, giving an average frost-free season of 168 days. Frost has been recorded at this station as early as September 11 and as late as May 25.

Table 1 gives the more important climatic data as recorded at the United States Weather Bureau station at Farmland in the western part of the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Farmland, Randolph County, Ind.*

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1919)	Total amount for the wettest year (1890)	Snow, average depth
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December.....	31.4	64	-14	2.60	0.62	1.90	6.0
January.....	27.1	70	-24	2.77	.80	6.57	8.6
February.....	29.0	70	-19	2.38	.93	3.91	6.2
Winter.....	29.2	70	-24	7.75	2.35	12.38	20.8
March.....	39.2	82	-2	3.59	3.83	3.96	4.8
April.....	50.2	87	18	3.55	3.77	3.57	1.1
May.....	60.8	94	30	3.90	3.33	5.89	.1
Spring.....	50.1	94	-2	11.04	10.93	13.42	6.0
June.....	69.8	98	37	4.09	1.30	4.60	.0
July.....	73.7	102	44	3.48	1.99	.90	.0
August.....	71.4	104	38	3.72	2.62	5.96	.0
Summer.....	71.6	104	37	11.29	5.91	11.46	.0
September.....	65.4	97	30	3.51	.45	9.02	.0
October.....	53.3	91	16	2.40	4.47	2.32	.7
November.....	41.1	74	2	2.78	1.37	3.30	1.9
Fall.....	53.3	97	2	8.69	6.29	14.64	2.6
Year.....	51.0	104	-24	38.77	25.48	51.90	29.4

AGRICULTURE

Agriculture has always been the primary interest of the people of Randolph County. The first settlements were made in the vicinity of Winchester or Alba in 1814. Settlers moved in rapidly, and by 1820 the population numbered 1,800. The county was organized in 1818 and included all the territory west of the Indian boundary line made by the Greenville Treaty in 1795 and north to the Michigan State line. It was changed to its present size and shape in 1820, with the rest of the territory attached to it as Wayne Township for judicial purposes, until 1825, when Wayne Township was organized into separate counties. The first county seat was located at its present site, Winchester.

As a large part of the county was originally wet, the land having good natural drainage was first cleared, in order to grow food crops. The first tile drains were laid in 1856, but very little tiling was done until 1885. The greatest amount of artificial drainage was done between 1900 and 1915. By 1915 the county had established a system of drains which has been steadily improved, until at present at least 85 percent² of the land is moderately well drained naturally or artificially.

Table 2 shows the acreage devoted to the principal farm crops, as reported by the Federal census from 1880 to 1930, inclusive. These data show the general trend of agriculture during the last 50 years. There are 2,815 farms.

TABLE 2.—*Acreage of principal crops in Randolph County, Ind., in stated years*

Crop	1879	1889	1899	1909	1919	1929
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Corn.....	61,034	63,047	72,829	80,440	78,110	63,785
Wheat.....	35,296	38,197	51,908	19,247	37,800	14,332
Oats.....	9,812	15,512	10,171	38,765	29,350	39,708
Rye.....	119	326	349	529	1,599	683
Barley.....	103	129	115	24	2,265	177
Potatoes.....		1,323	743	786	625	429
Tobacco.....	21	24	291	1,102	490	123
All hay.....	13,796	27,726	34,175	27,017	24,798	26,702
Clover.....			15,255	3,751	7,381	5,834
Timothy.....				15,388	6,896	17,056
Alfalfa.....			34	106	457	2,053
Other legumes for hay.....					37	1,484

SOILS AND CROPS

Randolph County lies in a region where soils, climate, and economic conditions favor the utilization of the tillable land for a diversified type of agriculture. The fertile soils, the well-distributed and high rainfall, the warm summers, and the length of the growing season are particularly favorable to corn. The climate, as well as the soil, is favorable for growing oats, wheat, legumes, and grasses for hay and pasture, and for many vegetables and fruits, all of which, when produced on the same farm, constitute a diversified agriculture.

The land is a till plain of the sag and swell type, cut by a number of shallow troughlike valleys. The surface relief of most of the

² Estimate by the county surveyor.

upland is so slightly undulating that the intervening shallow swales are only a few inches deep. In the northern half of the county the flat plain is broken by two low moraines crossing in an east-west direction, one occurring near the northern edge and the other near the central part.

The till plain is underlain by unconsolidated and mostly unassorted strata of clays, sands, and gravel, differing in thickness, which have accumulated by glacial processes, both ice-laid and water-laid. These glacial materials, especially those having the most influence on the soil, are of late Wisconsin age. Limestone underlies the glacial material and has no direct effect on the soil, with the exception of a small area in the northwestern part of the county where the depth to limestone ranges from only 2 to 3 feet below the surface.

The diversified agriculture may be attributed, for the most part, to the character of the soils and their distribution. All the soils, with the exception of three soil types and a phase, are favorable for ordinary agricultural use and may be called agricultural soils. The soils unfavorable for such usage occupy a comparatively small area, and they are described in this report as miscellaneous soil types. On the basis of certain predominant soil characteristics and other features that affect agriculture, all the agricultural soils can be grouped in two main divisions—light-colored soils and dark-colored soils.

The light-colored soils have been leached of plant nutrients to various extents. The dominant soils in this group are the Crosby. They are moderately well drained but have heavy or hard subsoils, on account of which, in the nearly level areas, some artificial drainage is necessary, in order to obtain the best crop returns. The less productive light-colored soils are Bethel silt loam and Homer silt loam, shallow phase. These soils are imperfectly drained and need more artificial drainage than any other soils of the group. The better, or well-drained, light-colored soils are members of the Miami, Bellefontaine, and Fox series.

The most productive soils are dark colored and are described in this report as a group of soils having certain common characteristics which give them similar significance in agriculture. They are naturally poorly drained and occupy shallow depressions and flats throughout the county. This group includes members of the Brookston, Abington, Westland, Clyde, Genesee, and Eel series. These soils have not been leached of plant nutrients to a great extent, but instead may have received plant nutrients in the run-off water from the light-colored soils occurring at higher elevations.

The outstanding cropping system is built around a 3-year rotation of corn, small grain, and clover, but in some parts of the county a similar cropping system is used, with corn grown 2 years in succession. The latter system is used principally in fields where dark-colored soils predominate. These cropping systems and other agricultural practices have a significance in the natural response of the soil.

The dark-colored soils are generally favorable to the production of such crops as corn, oats, and hay. Before drainage and tillage were attempted these soils were, with the exception of Genesee silt loam, nearly always wet. The high natural available supply of water helped to produce a luxuriant vegetation and tended to retard decomposition of the accumulated organic matter. In addition, these

soils have received plant nutrients washed from adjacent areas of light-colored soils lying at slightly higher elevations, or, on the soils along the larger streams and troughlike valleys, the material high in plant nutrients was deposited by water when the valleys were filled. Furthermore, these soils are productive because very little leaching has taken place and nearly all the plant nutrients have been retained.

On the contrary, leaching has taken place in the light-colored soils, and as a result soluble mineral matter, especially bases, and nitrogen have been carried away through the drainage water. The run-off is comparatively rapid, and very little organic matter and nitrogen have accumulated. Although these soils have heavy subsoils and have a comparatively high water-holding capacity, the supply of water available to plants is not so high as it is in the dark-colored soils, and during the drier seasons some crops, especially corn, are damaged by drought.

From the characteristics and features here pointed out, it is apparent that the dark-colored soils and light-colored soils differ in inherent productivity, and in order to obtain the best crop returns different management is necessary for the two kinds of soils. On the dark-colored soils, or in fields where they predominate, corn can be grown more often in the crop rotation, and less attention is given to growing legumes. On most of the farms, the distribution of the light-colored soils and dark-colored soils (pl. 1, A) is irregular, and in order to utilize the legumes and hay grown to maintain the productiveness of the light-colored soils, livestock raising has become important. Hog raising is important, but on most farms, especially the larger ones, dairy or beef cattle are raised. Raising livestock on the farm allows the legumes to be used as hay and pasture, allows the corn to be fed on the farm, and provides barnyard manure to be spread over the areas of light-colored soils. Very little corn, except that grown in the northern part of the county, is marketed as a cash crop.

Fruits and vegetables are grown and poultry is raised on nearly all farms to supply home needs or local markets, but on only a few farms do any of these constitute a well-developed specialty.

In the following pages, the soils of Randolph County are described in detail, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 3.

TABLE 3.—*Acreage and proportionate extent of soils mapped in Randolph County, Ind.*

Type of soil	Acre	Per- cent	Type of soil	Acre	Per- cent
Crosby silt loam.....	73,472	25.7	Eel silty clay loam, dark-colored phase.....	4,992	1.7
Crosby silty clay loam.....	56,896	19.9	Eel silt loam.....	256	.1
Miami silt loam.....	27,584	9.6	Genesee silt loam.....	16,560	3.7
Miami silt loam, level phase.....	3,392	1.2	Abington silty clay loam.....	2,816	1.0
Miami silty clay loam, slope phase.....	2,048	.7	Westland silty clay loam.....	4,736	1.6
Miami silty clay loam.....	16,512	5.7	Clyde silty clay loam.....	2,560	.9
Bellefontaine silt loam.....	640	.2	Carlisle muck.....	192	.1
Fox silt loam.....	2,752	.9	Walkill silty clay loam.....	64	.1
Bethel silt loam.....	1,344	.5	Gravel pits.....	128	.1
Homer silt loam.....	192	.1			
Homer silt loam, shallow phase.....	128	.1			
Brookston silty clay loam.....	74,816	26.1	Total.....	286,080	-----

LIGHT-COLORED SOILS

The upper layers of all the soils of this group have been leached, and consequently the soils are comparatively low in bases, organic matter, and nitrogen. They have light-colored surface soils and are easily distinguished from the dark-colored soils with which they are intimately associated. The natural productivity of the several soils in this group differs to some extent, but the practical problems in the management of the soils are more or less similar. With proper attention given to their management they satisfactorily produce all ordinary crops adapted to the county. But these soils are so scattered in small irregularly shaped areas, and they are so intimately associated with the more productive dark-colored soils that it is difficult, on most farms, to give them special attention in the crop rotation.

In most places these soils have an acid reaction in their surface soils and subsoils, but legume hay can be grown without a great deal of additional treatment. Lime, manure, and other farm residues are applied in as large quantities and as often as possible. Corn, small grains, and clover constitute the most used short rotation on these soils.

The characteristics of the light-colored soils from their surfaces to a depth of about 3 feet change so distinctly and so consistently that distinct layers may be distinguished. In cultivated fields the surface soils range in color from light grayish brown to grayish brown to a depth of about 8 inches, or to the depth that the land has been tilled. Below the surface soil certain characteristics are revealed in the different layers, which can be consistently correlated with the surface soil and with features affecting crop production. In view of this, for convenience in discussing the soils of this division, they may be arranged in subgroups, each named for a dominant or characteristic soil of the subgroup. These are the Miami group, the Crosby group, and the Bethel group. All the subgroups, with the exception of the Crosby, contain members of two or more soil series.

SOILS OF THE CROSBY GROUP

The Crosby group includes two soil types, Crosby silt loam and Crosby silty clay loam, which are geographically separated, Crosby silt loam occurring in the southern half of the county and Crosby silty clay loam in the northern half. Their characteristics, crop yields, distribution, and association with dark-colored soils are comparable. These soils occupy areas with very gently undulating surface relief. They are confined to the upland and are almost everywhere intimately associated with Brookston silty clay loam, a dark-colored soil. The soil characteristics vary somewhat, according to the slope of the land. In areas having the steeper slopes the characteristics approach those of Miami silt loam, or Miami silty clay loam, and in the flat areas they approach those of Bethel silt loam. In many places mapped areas of Crosby silt loam and Crosby silty clay loam include small patches of Bethel silt loam. When vegetation covers the surface of the ground, the extent of an area of Crosby silt loam cannot always be determined easily, because the difference in elevation between an area of this soil and adjoining areas of other soils, especially Brookston silty clay loam and Bethel silt loam, may not be more than a few inches.

The natural productiveness of these soils is not so high as that of the soils of the Miami group and is distinctly less than that of the dark-colored soils, but with some attention given to applying barnyard manure, tiling, and growing legumes, their productiveness can be increased. With the exception of a few very small areas which are neutral in reaction, the soils have a medium-acid reaction to a depth of about 20 inches, and, in most places, clover can be grown without liming. The conditions, however, for starting clover are much less favorable than on the dark-colored soils. Corn is the most important crop grown on these soils, and wheat ranks second. Corn is not naturally so well suited to these soils, as it starts slowly in the spring and in some places fails to mature. With proper management in crop rotation and by spreading all available manure on the spots where corn does not do well, the yields may be materially increased. Plate 1, *B*, shows a heavy growth of sweetclover on Crosby silt loam.

Crosby silt loam.—Under cultivation the surface soil of Crosby silt loam consists of light grayish-brown or grayish-brown friable gritty silt loam, about 8 inches thick. The texture of the subsoil, between depths of 8 and 18 inches, ranges from heavy silt loam in the upper part to heavy clay loam in the lower part. The color of the material is yellow or yellowish brown, mottled with gray, and as depth increases the gray mottling decreases and the material becomes dark yellowish brown. This layer is underlain, to a depth of 24 inches, by material comparable to that of the lower part of the layer above. The material in this layer, except in the poorly drained areas, contains no gray mottling and is not so compact and impervious as that in the layer above. The depth to free lime carbonates differs considerably in different areas, but in most places it is about 24 inches.

Crosby silty clay loam.—The southern limit of the areas of Crosby silty clay loam is placed at the southern border of the Union City moraine. This soil differs from Crosby silt loam in having a slightly heavier textured subsoil and, where it has been cultivated, a heavier textured surface soil. The average depth to free lime carbonates is about 2 inches less than in Crosby silt loam. The heavy-textured subsoil is also somewhat closer to the surface, in most areas being within plow depth, and during cultivation it is mixed with the surface soil, giving it a slightly heavier texture than the surface soil of Crosby silt loam. Soil-management practices and yields of crops are similar to those on Crosby silt loam.

SOILS OF THE MIAMI GROUP

The soils included in the Miami group are Miami silt loam, Miami silty clay loam, Fox silt loam, Bellefontaine silt loam, Miami silt loam, level phase, and Miami silt loam, slope phase. Although the surface relief of these soils in some places ranges from slightly undulating to nearly level, their characteristics nearly everywhere indicate good drainage, and very little evidence of water-logging in the subsoils can be seen, even in the flatter areas. Good drainage of the subsoil material is indicated by a reddish-brown or a well-oxidized yellowish-brown mottling. Very little tiling or artificial drainage is

necessary for the soils of this group, although some areas of Miami silty clay loam, having especially heavy subsoils, would be benefited by tiling.

The soils of this group are the most productive light-colored soils in the county, and, with proper management, can be made nearly as productive as most of the dark-colored soils. These soils in many places are neutral in the surface layers, and all the clovers adapted to this section, with the exception of sweetclover, can usually be grown without the addition of lime.

Miami silt loam and Miami silty clay loam occur on the upland and are underlain by heavy-textured glacial till. They are associated with the two Crosby soils. Miami silt loam, which occurs in the southern part of the county, is confined to small strips of land near the streams, to rolling well-drained areas between the streams, and to the well-drained knolls and ridges on the upland till plain. Miami silty clay loam occurs in the northern part of the county and is confined almost entirely to the Mississinewa and Union City moraines. Miami silt loam, level phase, lies south of Mississinewa and White Rivers in a terracelike position, and it is underlain by gravel at a depth of about 8 feet. Fox silt loam lies along the larger streams on terraces having gravel substrata. Bellefontaine silt loam is also underlain by gravel and is comparable to Fox silt loam. It occurs only in areas where the morainic relief consists of narrow ridges or kames. The surface of Bellefontaine silt loam is more sloping than that of Fox silt loam.

Miami silt loam.—The cultivated surface soil of Miami silt loam, to a depth of about 7 inches, is light grayish-brown friable silt loam. Below the surface soil the material rather abruptly grades into yellowish-brown or brown clay loam which in most places is free from mottling. This heavy-textured material extends to an average depth of 26 inches, below which the material consists of slightly weathered friable calcareous till. The depth to free lime carbonates differs considerably in different areas. It may occur within 15 inches of the surface in places where the slope is steeper than usual and the heavy-textured subsoil is closer to the surface. In such areas the surface soil is in general neutral in reaction.

Although the subsoil material of Miami silt loam is heavy and water moves through it slowly, the surface soil is nearly everywhere so well drained that tiling is not necessary. In areas where internal drainage is comparatively poor the subsoil contains some faint mottling, like that in the subsoil of Crosby silt loam.

Miami silt loam, level phase.—The level phase of Miami silt loam occurs for the most part in nearly level or very slightly undulating areas occupying terracelike positions just south of White River. Areas as level as those in which this soil occurs are ordinarily occupied by Crosby silt loam, and it seems probable that the coarse gravel, which in this soil lies about 8 feet below the surface, has provided sufficient underdrainage to prevent the development of a type of soil such as Crosby silt loam. The characteristics of the level phase of Miami silt loam resemble closely those of the typical soil, but the silt loam surface layer is thicker and the calcareous till is reached at a greater depth. The subsoil, however, is thicker and the material is not quite so compact and heavy textured as in typical

Miami silt loam. In most places the material in the subsoil has a more distinctly yellow color and shows no indication of poor drainage. The depth to carbonates is about 30 inches, and from this depth to the underlying gravel the material is friable gritty slightly gravelly clay loam. Artificial drainage is not necessary in this soil, except where the surface relief is very nearly level or in areas intimately associated with Brookston silty clay loam. Corn produces well, and with some attention given to soil management this soil can be made nearly as productive as Brookston silty clay loam.

Miami silt loam, slope phase.—Miami silt loam, slope phase, is confined to the short steep slopes bordering streams. It occupies a comparatively small area and is not used for cultivated crops because of the steepness of the slopes. In general, its soil characteristics are similar to those of typical Miami silt loam. It is largely in woodland or pasture, to which use it is well adapted.

Miami silty clay loam.—Miami silty clay loam is the dominant well-drained upland soil in the northern part of the county, where it occurs on the more rolling land of the moraines and on the well-drained slopes along the more deeply incised streams. It is associated with Crosby silty clay loam and Brookston silty clay loam. It is similar to Miami silt loam, the chief differences being in the thickness of the surface soil, which is only 5 or 6 inches, and the heavier or more clayey texture of the subsoil of the silty clay loam. The depth to the limy parent material averages between 15 and 18 inches, which is distinctly less than in Miami silt loam.

This land is used in the system of general farming common to the county. It is, because of its heavier texture, somewhat less well adapted to cultivated crops than Miami silt loam and is better suited to pasture and wood lots. This is especially true of the more sloping areas, where, under cultivation, erosion tends to remove the silt loam surface layer.

Bellefontaine silt loam.—Bellefontaine silt loam, in most places, occurs in close association with Miami silt loam. The characteristics of the surface soils of the two soils, to a depth of 18 inches, are similar, but the Bellefontaine soil is underlain, at a depth of about 32 inches, by sand and gravel, high in carbonate of lime. Although the gravelly and sandy material is readily pervious to water, the soil is not exceptionally droughty, because of the heavy texture of the material above the gravelly and sandy substratum, or between depths of 15 and 30 inches. The thickness and heaviness of this material differs somewhat in different places. In areas where the depth to the gravel substratum is slight, the silt loam surface soil is thinner and is brown wherever the soil is cultivated. Many small bodies of this soil are included with mapped areas of Miami silt loam. Most of the land is cultivated, but where it occurs in comparatively large areas, where the surface relief is very sloping, or where the surface soil contains a large quantity of gravel, it is used as pasture land.

Fox silt loam.—The total area occupied by Fox silt loam is not large. This soil is productive, and the surface relief is favorable to cultivation, but it occurs in small areas, and, consequently, is comparatively unimportant agriculturally. It occupies terraces having gravel substrata. It occurs only on the Mississinewa and White River terraces and in the larger sloughs or troughlike valleys. The characteristics of the subsoil are comparable to those of the

subsoil of Bellefontaine silt loam, but in most places the surface soil and upper subsoil layers are somewhat thicker than in the Bellefontaine soil, and the texture is more uniformly silt loam.

SOILS OF THE BETHEL GROUP

The three soils comprising the Bethel group are Bethel silt loam, Homer silt loam, and Homer silt loam, shallow phase. These are the least productive and the most poorly drained light-colored soils. They occupy small flat areas intimately associated with the Crosby soils and the dark-colored soils. Their generally flat surface relief and the heavy impervious subsoils make these soils more urgently in need of artificial drainage than any other light-colored soils.

These soils have very light gray surface soils which are naturally low in organic matter, nitrogen, and other available plant nutrients. The heavy, somewhat compact, poorly aerated, and poorly drained subsoils cause unfavorable conditions for crops during periods of excessive rainfall, and, except in years of very favorable temperature and well-distributed rainfall, crop yields are considerably less than on any soils in the Crosby or Miami groups. The characteristics of the soils of the Bethel group resemble more closely the characteristics of the Crosby soils than they do those of the soils of the Miami group. In cultivated areas the soils of the Bethel group have lighter colored surface soils than those of the Crosby group, and their subsoils have more gray mottling, which indicates poorer drainage. On some farms, much attention is given to draining areas of these soils, applying manure, and growing legumes, whereas on other farms practically no attempt has been made to improve them. Wherever possible, or where these soils occur in larger areas, they are uncultivated and are used for wood lots.

Bethel silt loam.—The dominant characteristics of Bethel silt loam are the 10- or 12-inch surface layer of very light gray or light grayish-brown friable silt loam, containing some small iron concretions, and the heavy mottled silty clay loam subsoil occurring between depths of about 12 and 32 inches. In wooded areas, this soil has a surface layer of dark grayish-brown or grayish-brown silt loam 2 or 3 inches thick. This is underlain by very light gray or almost white silt loam which, when the soil is cultivated, is mixed with the surface material, producing a lighter colored surface soil.

Bethel silt loam occupies flat or very slightly depressed areas of the upland, in close association with the Crosby soils and Brookston silty clay loam. The leached or impoverished surface soil and the poorly drained and poorly aerated subsoil render this soil unproductive, particularly for corn. The surface soil is low in organic matter and mineral plant nutrients, and it puddles readily if cultivated when wet. The heavy and impervious subsoil makes it necessary to lay tile lines closer for adequate underdrainage than in any other soils of this group.

Homer silt loam.—The surface soil of Homer silt loam consists of an 8-inch layer of light-gray friable silt loam grading into mottled gray, yellow, and brown silt loam which extends to a depth of about 14 inches. Underlying this material is a 12-inch layer of mottled gray and yellow heavy clay loam comparable to the material at a corresponding depth in Bethel silt loam. This layer, in turn, is

underlain by a layer of brown or reddish-brown clay, ranging in thickness from 2 to 12 inches, which overlies stratified sand and gravel and is similar to the material overlying the gravel substratum of Fox silt loam.

This soil is unimportant agriculturally because of its small total acreage. The characteristics of the surface soil and the upper part of the subsoil are variable, in some places resembling more nearly those of Crosby silt loam than those of Bethel silt loam.

Areas of Homer silt loam occur on the large terraces in association with the Fox soils, and many small spots of the Homer soil are included in mapping with the Fox, Westland, and Abington soils. Very little attention is given this soil because it occurs in small irregularly shaped areas intimately associated with other soils.

Homer silt loam, shallow phase.—Homer silt loam, shallow phase, occurs in a few small areas in the northwestern part of the county, occupying only the low flat land south of Mississinewa River. The dominant characteristic of this soil is the mottled gray and yellowish-brown silty clay loam subsoil, between depths of 16 and 30 inches, overlying bedrock of dolomitic limestone. The color of the surface layer, to a depth of 14 inches, differs somewhat in different areas, but in most places where surface drainage is fair, the color of the material to this depth is similar to the color of Bethel silt loam at a corresponding depth. The surface soil in areas adjacent to Abington silty clay loam, and occurring at about the same level, is darker gray. The organic-matter content is low, as the color indicates, and the silty material compacts when wet, in which respect it is comparable to Bethel silt loam. The subsoil, however, differs from the subsoil of Bethel silt loam in texture and color. The texture is lighter, the color is reddish brown similar to that of Fox silt loam, and there is less gray mottling.

Homer silt loam, shallow phase, is one of the most acid soils of this group, having an acid reaction from the surface to within a few inches of the limestone bedrock. The management and treatment of this soil differ very little from those of Bethel silt loam. Although the subsoil is not so heavy or so impervious as that of Bethel silt loam, underdrainage is as poor, owing, probably, to the massiveness and imperviousness of the underlying rock. Very few areas have been drained, because the nearness of the bedrock to the surface practically prohibits tile drainage.

DARK-COLORED SOILS

The dark-colored soils are highly productive and are especially adapted to corn. They occur in all parts of the county and are, for the most part, intimately associated with the light-colored soils. All these soils, with the exception of one type, have poor natural drainage, but practically all areas are now sufficiently well drained artificially to keep the water table below a depth that would be harmful to crops. They are well supplied with organic matter and nitrogen, and other plant nutrients are sufficiently available, so that by growing legumes in the rotations and utilizing crop residues the soils can easily be kept productive. Probably the treatment of these soils on many farms would be different if they were not so intimately associated with the light-colored soils, as their management is influ-

enced largely by the amount of light-colored soils in the same field in which they occur. In fields where the dark-colored soils predominate, more corn can be grown in the crop rotation and less attention be given to growing legumes and hay for maintaining the organic matter and nitrogen supply than in fields where the light-colored soils predominate. In some fields where the soils are predominantly dark colored, especially in the northern part of the county, corn is grown 2 or more years in succession, in rotation with clover.

Where the dark-colored soils are fairly well drained, crop injury, because of wet conditions, rarely occurs. The soils warm up slowly in the spring, and the growth of early planted crops is retarded. The tendency of the ground to heave during freezing and thawing is injurious to wheat and renders these soils unfavorable for that crop. In many places it is more difficult to start clover than on the light-colored soils, because of poor drainage, but wherever a stand is obtained the dark-colored soils produce well.

Brookston silty clay loam.—Brookston silty clay loam is one of the most productive soils in the county, and very nearly all the land is under cultivation. Where the soil is cultivated, the 6-inch surface layer is very dark brown or dark grayish-brown crumbly silty clay loam containing much organic matter. The color of the surface soil differs according to the quantity of moisture in the soil material and, in most places, according to drainage conditions or the position of the soil. When the material is dry it is much lighter in color than when wet, as it is then nearly black. The thickness of the surface soil noticeably colored by organic matter differs considerably in different areas, but in most places it is about 14 inches. Between depths of 6 and 14 inches the material is dark grayish-brown silty clay loam that, in most places, has a strong tendency to break into sharp angular particles. The texture of the material in this layer is very nearly the same as that in the layer above. This layer varies considerably in thickness. In most places, below a depth of 14 inches, the material is gray coarsely granular heavy silty clay loam which extends to a depth of about 24 inches and is mottled with yellow and dark-brown or rust-brown spots. Between depths of 24 and 54 inches, the breakage of the material into structure particles becomes less distinct and the texture slightly heavier. In most places the color of the material in this layer differs very little from that in the layer above, but in some places the gray material in the upper part of the layer grades into yellowish-brown clay loam mottled with gray. Below a depth of about 54 inches, the material is gray and yellowish-brown calcareous glacial till of clay or clay loam texture, which contains much coarse-textured material.

Areas of Brookston silty clay loam are irregularly distributed, and they range in size from less than an acre to more than 40 acres. The areas are intimately associated with bodies of the Crosby soils, and in very few places does the Brookston soil occupy a sufficiently large area that the treatment of the soil is not influenced by the light-colored soils.

Brookston silty clay loam is especially well adapted to corn. Yields range from 40 to 60 bushels an acre in years of sufficient and well-distributed rainfall and a normal growing season. In particularly favorable seasons and on well-managed and fertile fields, yields as high as 80 bushels an acre have been obtained. Well-

drained areas return good yields of oats, wheat, and clover. Timothy, soybeans, and sweetclover generally give heavier yields than on the light-colored soils.

Eel silty clay loam, dark-colored phase.—Very nearly all of Eel silty clay loam, dark-colored phase, is cultivated. Most of this soil occupies areas along small streams, especially near the headwaters, and is subject to overflow. The surface soil is loose friable very dark grayish-brown or dark grayish-brown silty clay loam. The color differs considerably in different places, depending on the amount and color of the fresh grayish-brown material deposited by overflow. Below the surface layer, which consists of fresh alluvium, the material in nearly all areas becomes much heavier and is dark colored to a depth of 12 or 14 inches. Between depths of 12 and 30 inches the material is mottled gray and brown silty clay loam comparable to the subsoil of Brookston silty clay loam at a corresponding depth, but it differs, in most places, from that of Brookston silty clay loam in containing more gray material and less brown. Below a depth of 30 inches the material is mottled grayish-yellow heavy silt loam, with some stratification indicative of water-laid origin. The structure of the subsoil is comparable to that of the subsoil of Brookston silty clay loam.

Crop yields on this soil are nearly equal to those obtained on Brookston silty clay loam. Management of the soil, also, is comparable to that of the Brookston soil, and nearly everywhere the land has been equally well drained by ditching.

Eel silt loam.—The surface soil of Eel silt loam consists of an 8- or 10-inch layer of grayish-brown or light grayish-brown silt loam underlain by mottled gray and brown silt loam or loam. In a number of areas, the material below a depth of 20 inches changes to bluish-drab clay loam. This soil is of comparatively little importance agriculturally, because of its small acreage and because of the small proportion of the land farmed. Most of it occurs in small bodies, where surface drainage is very poor, and in low spots, where the normal ground-water level is somewhat nearer the surface than it is in the adjoining areas. Practically no attempt has been made to drain this soil, and the subsoil is kept saturated with seepage water. About half the total area of Eel silt loam has been cleared of its forest cover and is now used as pasture and hay land.

Genesee silt loam.—Genesee silt loam includes all the well-drained brown soil along the streams, and most of it occurs in small irregular areas. The land is subject to frequent flooding. This soil consists of recently deposited alluvium, and its characteristics differ considerably in different areas, but most of it is brown or dark-brown material of various textures from the surface downward.

All the ordinary crops of the county produce well on this soil, and, although it is everywhere nearly level, artificial drainage is not necessary. Most of the areas lying along White and Mississinewa Rivers are uncultivated and are used as pasture land.

Abington silty clay loam.—Abington silty clay loam is the dominant soil on the terraces of White River and Mississinewa River and in the long depressions and sloughs, which are so extensive. The surface soil and upper part of the subsoil are comparable to those of Clyde silty clay loam, except that, in most places, the texture is

slightly heavier and the surface soil is darker. The surface soil consists of dark grayish-brown or black heavy silty clay loam, about 15 inches thick, which gradually changes to the underlying lighter colored material consisting of mottled gray, yellow, and brown heavy silty clay loam. Between depths of 24 and 30 inches the material is light-gray or drab plastic heavy silty clay. This material is underlain by gravel in an earthy matrix of yellowish-brown clay loam, and below this are beds of gravel, which were formerly saturated with water.

Abington silty clay loam was normally poorly drained, but now very nearly all of it is adequately drained, and the land does not become too wet for crops. This soil is almost everywhere slightly more productive than Brookston silty clay loam. Soil management and agricultural practices are comparable to those on the other dark-colored soils.

The variations in this soil, as mapped, occur along the edges of the terraces and uplands where separation of this soil and Brookston silty clay loam is difficult, because in many places the two soils grade into each other, from the Brookston soil on the upland to the Abington soil on the lower position, or terrace.

Westland silty clay loam.—Westland silty clay loam occurs on terraces and is closely associated with Abington silty clay loam. The 6- or 8-inch surface layer consists of very dark brown silty clay loam. It is high in organic matter and is comparable in other characteristics to the surface soil of the Brookston, Eel, and Abington soils. The material between depths of about 6 and 24 inches is mottled gray and brown silty clay. In most places this layer contains considerable organic matter, but in some areas there is more gray mottling and the soil material closely resembles the subsoil of Brookston silty clay loam at a corresponding depth. This material grades into mottled gray and dark-yellow silty clay, between depths of 28 and 34 inches, which is underlain by a 14-inch layer of yellow gritty clay loam showing very little gray mottling. Stratified calcareous sand and gravel are present at a depth of about 52 inches.

Although natural drainage of Westland silty clay loam is imperfect, the lower part of the subsoil is somewhat better drained than that of the other dark-colored soils, because in most places the water table is slightly lower and the porous sand and gravel favor good natural and artificial drainage. The management of this soil differs very little from that of the other dark-colored soils, and crop yields are comparable with those obtained on Brookston silty clay loam.

Clyde silty clay loam.—Clyde silty clay loam is closely associated with Brookston silty clay loam, and it occupies the lower and wetter parts of the depressions in the uplands. The surface soil consists of a 10-inch layer of very dark gray or black silty clay loam or silty clay, underlain by a 10-inch layer of very dark gray silty clay which becomes lighter in color with depth until, at a depth of about 18 inches, the color is mottled gray or drab gray and rust brown. The material of this layer, which lies between depths of 18 and 50 inches, is predominantly drab, but it contains numerous spots and streaks of rust brown. Another predominant characteristic of the material in this layer of the subsoil of Clyde silty clay loam is its natural breakage into small sharp angular particles having smooth sides. The material

below a depth of 50 inches consists of mottled gray and yellow silty clay loam high in free carbonates of lime, most of which occur in the form of concretions.

Clyde silty clay loam as mapped includes bodies of a soil having a light-gray highly calcareous silty clay subsoil overlain by a 6- to 10-inch layer of black or dark-gray silty clay loam very high in organic matter, which, when dry, is very chaffy. These included bodies have very little agricultural importance. They are confined very largely to the outer borders of areas of Carlisle muck.

The management of Clyde silty clay loam is comparable to that of the other dark-colored soils, and where this soil has been artificially well drained it is one of the most productive of these soils. Most of the larger areas are drained, but many of the smaller ones still remain as ponds in uncultivated wooded areas. Marl occurs in the subsoil of Clyde silty clay loam in places, and much of it contains a sufficiently high percentage of lime carbonate and occurs in large enough quantities to be used as a source of lime.

MISCELLANEOUS SOIL TYPES

A number of soil types in Randolph County are comparatively unimportant and are not used for the ordinary general agriculture, because of their small acreage, and because of characteristics and features which make them unproductive or unsuitable for farming operations. The characteristics of these soils differ considerably from those of the soils previously described.

Carlisle muck.—The largest areas of Carlisle muck occur in the southeastern part of the county, and smaller bodies occupy depressions in other places. Small parts of the larger muck areas have been ditched, and an attempt has been made to cultivate the land. Where the areas are not large, general-farm crops, and a few truck crops, including mint, are grown. Most of the smaller bodies are cultivated in connection with the adjoining soils. Muck land, where the deposit is not too thick and where the areas are cultivated, produces comparatively well, although it is deficient in potash. The muck in the larger bodies, to a depth of about 8 inches, consists of black decomposed organic matter which contains some mineral matter. Between depths of 8 and 18 inches, the material consists of black partly decomposed organic matter and finely divided plant remains. Below a depth of 18 inches the organic matter is less decomposed and has a yellowish-brown color. Here the material contains numerous shells.

Carlisle muck everywhere is of the nonacid type. In the smaller bodies it contains considerably more mineral matter in the surface layer, and the organic material is more thoroughly decomposed. Most of the smaller areas are associated with bodies of Clyde silty clay loam. Many of the larger areas of Carlisle muck are underlain by deposits of marl, and such areas generally occur at the outer borders of the typical areas.

Wallkill silty clay loam.—A number of areas of soil having about 6 inches of black or very dark brown silty clay loam overlying muck are separated on the map and are correlated as Wallkill silty clay loam. The surface material of most of these areas is high in organic matter, and it overlies organic matter comparable to that occurring in small areas of Carlisle muck at a corresponding depth.



A, Air view taken southeast of Lynn, showing sec. 13, R. 14 E., T. 18 N., in foreground, illustrating the typical "black and clay" land; *B*, heavy growth of sweetclover on Crosby silt loam.



Aerial photograph (taken from a comparatively low altitude) including the Herbert Davis Forestry Farm located on Ball State University.

Nearly all the areas of Wallkill silty clay loam are small, and they are nearly everywhere associated with the dark-colored soils. These areas are cultivated in connection with the adjacent soils. In many places this soil is deficient in potash, and corn and other common crops do not produce well.

Gravel pits.—There are numerous gravel pits in the county, which, because of their importance as a source of road-building material, are indicated on the map by symbols. Most of these areas are associated with Fox silt loam and Bellefontaine silt loam, and they have no agricultural value. Gravel is still being removed from some of these pits, but in many of them the supply has been exhausted.

SOILS AND THEIR INTERPRETATION

Randolph County lies within the region of gray-brown podzolic soils which are light colored. The region has a temperate humid climate and originally had a forest cover of deciduous trees. The relief is that of a till plain of the sag and swell type, and the upland in most sections is so slightly undulating that the intervening shallow swales are only a few inches deep. The parent material of the soils, which was accumulated during the late Wisconsin glacial age, is composed of unconsolidated clays, sands, and gravels.

There are 20 soil separations made on the soil map of Randolph County, each of which discloses certain definite characteristics and features that are consistent to it within the county, and these features and characteristics are used as a means of separating and classifying the soils into soil series and types. Many of these characteristics can be seen in a vertical section of a soil, known as a soil profile. The features commonly seen in a soil profile and having significance in classifying soils are the number, texture, color, thickness, structure, relative arrangement, and chemical composition of the various layers. Each layer has a certain amount of uniformity in characteristics and lies approximately parallel to the surface of the ground.

Of the 20 soil separations, 16 are considered as distinctly different soil types which are members of 14 different series, and each type is distinguished from the other by field examination. Four separations are called phases of types. They are based on minor differences in characteristics or on features other than soil characteristics, such as the character and depth of the underlying material and the type of relief on which they occur. These 20 soil separations disclose certain relationships existing within their large divisions, or groups. Eight soil types and 3 phases have light-colored surface soils, and on the basis of this and several other characteristics, they are classified as members of a light-colored soil group. Another soil group includes 6 soil types and 1 phase, which have dark-colored surface soils. A miscellaneous group includes 2 soil types consisting chiefly of organic material.

The characteristics of the Miami soils are considered typical of the normal soils of the region. Besides the light color of the surface soils, these soils have an upper eluviated layer which has lost material, owing to chemical and physical action, and a lower illuviated layer which has apparently gained finer textured materials. It is evident that these characteristics have resulted from the processes of soil development. Although the underlying parent material,

which begins, in most places in this county, at a depth between 24 and 34 inches, may differ considerably, the Miami and associated light-colored soils all have a comparatively light-textured surface soil and a heavy-textured subsoil. Although the number and arrangement of the natural soil layers may be similar, there are marked differences in the characteristics of the layers in the different soils. The characteristics of these soils may be correlated with differences in relief and drainage as well as with differences in the substrata.

The members of three series in the group of light-colored soils—Miami, Crosby, and Bethel—are all derived from, or have as their underlying parent material, unconsolidated heavy glacial till of late Wisconsin age. The other light-colored soils, which are members of the Fox, Homer, and Bellefontaine series, have water-laid and assorted substrata.

Miami silt loam, which has distinctive soil layers, may be regarded as the characteristic normally developed soil of the county. This soil is intricately associated with Crosby silt loam, and these two soils occur in the southern part of the county. The surface relief of Miami silt loam is nearly everywhere undulating, and the land is well drained. In a wooded area covered by partly decomposed leaves, where the tree growth consists of white oak, shagbark hickory, and sugar maple, three-tenths of a mile west of the northeast corner of sec. 34, T. 19 N., R. 12 E., a typical area of Miami silt loam shows a profile described as follows:

- A₁. 0 to 1 inch, very dark brown structureless silt loam high in organic matter. Many fine roots occur in this layer. The pH value is 6.5.³
- A₂. 1 to 3 inches, dark grayish-brown finely granular or structureless silt loam. The material shows slight evidence of granulation, but the natural lines of cleavage are feebly expressed. A little sprinkling of gray material occurs on the outsides of the structure particles. The pH value is 6.2.
- A₃. 3 to 7 inches, friable light yellowish-gray silt loam. The natural breakage is indistinct, but some structure particles are formed. The pH value is 5.1.
- B₁. 7 to 10 inches, pale-yellow heavy silt loam having a sprinkling of gray on the outsides of the structure particles. The structure particles in this layer are much more distinct than in the layer above. They are subangular and range from one-fourth to one-half inch in diameter. The pH value is 4.8.
- B₂. 10 to 14 inches, the heaviest textured layer in the profile. The material of this layer is dark yellowish-brown silty clay loam or clay loam. Some sprinkling of gray material occurs on the outsides of the structure particles, and the soil material breaks readily into angular fragments ranging from one-fourth to three-fourths inch in diameter. The pH value is 4.8.
- B₃. 14 to 20 inches, brown heavy silty clay loam. The breakage of the material is distinct, forming structure particles of about the same shape as those in the layer above, though somewhat larger. The pH value is 5.0.
- B₃₁. 20 to 28 inches, material similar to that in the layer above, except that it is distinctly less acid. The pH value is 6.8.
- C. 28 inches +, the underlying glacial till consisting of structureless grayish-yellow silty clay loam containing some grit. The pH value is 8.2.

The other separations of the Miami series are Miami silty clay loam, Miami silt loam, level phase, and Miami silt loam, slope phase. Miami silty clay loam occurs in the northern part of the county in-

³ pH values (hydrogen-ion concentration) determined by E. H. Bailey, Bureau of Chemistry and Soils.

tricately associated with Crosby silty clay loam. The southern limit of any areas in which these two soils are mapped coincides with the southern boundary of the Union City moraine. The texture of Miami silty clay loam is slightly heavier than that of Miami silt loam, and the average thickness of each layer in the profile is less. The average depth to carbonates in Miami silty clay loam is about 20 inches, or about 6 inches less than the average depth to lime in the silt loam section of the county. The other characteristics of Miami silty clay loam and Miami silt loam are comparable.

Although the surface relief of Miami silt loam, level phase, is nearly level or very gently undulating and surface drainage is poor, the characteristics of this soil are comparable to those of typical Miami silt loam which has good surface drainage. Internal drainage is good because of the porous gravelly substratum which underlies the soil and heavy-textured parent material at a depth of about 8 feet. The characteristics of this soil have undoubtedly been influenced by the deep gravelly substratum. The main layers, or horizons, are thicker and the carbonates and unweathered heavy glacial material occur at greater depths than in the other Miami soils. The surface soil is browner, and the subsoil averages more friable and more yellow. The clay in the subsoil is not so heavy, compact, and impervious as that in the subsoil of Miami silt loam. The comparatively friable subsoil allows easy penetration of water to the porous substratum, where it readily seeps away. Similar soil has been mapped elsewhere as a terrace phase of Miami silt loam, but in Randolph County the areas are not distinctly second bottoms.

The characteristics of Miami silt loam, slope phase, are comparable to those of typical Miami silt loam. Lime carbonates occur in eroded areas within a foot of the surface, and all layers of this soil are thinner than those of typical Miami silt loam.

Bethel silt loam is more poorly drained than any other light-colored soil. It is an imperfectly drained upland soil derived from the same kind of glacial till as the Miami soils. It has developed under a similar forest cover. This soil occurs in a comparatively few small areas, intricately associated with the dark-colored soil of the depressions, Brookston silty clay loam, and the somewhat better drained light-colored Crosby soils. The dominant characteristics of this soil are the light-gray or almost white surface soil and the mottled gray, yellowish-brown, and yellow plastic heavy impervious clay or clay loam subsoil. This soil is greatly leached or podzolized, and the soluble salts are removed from the upper layers. The surface soil and the upper part of the subsoil are somewhat more acid than the corresponding layers of the Miami soils.

The Crosby series includes the two dominant light-colored soils—Crosby silt loam and Crosby silty clay loam—which are associated with, and analogous in texture, depth of development, and depth to carbonates to Miami silt loam and Miami silty clay loam, respectively. The Crosby soils occupy gently undulating uplands where drainage conditions are intermediate between those of Bethel silt loam and those of the Miami soils. The Crosby soils have medium light colored surface soils and mottled gray, yellow, and yellowish-brown heavy slightly impervious subsoils. The subsoils are not so highly mottled with light gray and are not so impervious as the

subsoil of Bethel silt loam. Numerous included spots, either too small or too irregular to map separately, of soil similar to both the Bethel and Crosby soils are neutral in reaction in all layers instead of being distinctly acid in the subsoils, as is normal for the Crosby soils.

Three soil types have water-laid substrata. These are Fox silt loam and Homer silt loam occupying terrace, or second-bottom, land and Bellefontaine silt loam occurring on undulating or rolling upland. The Fox and Bellefontaine soils are underlain by gravel and are well drained, and Homer silt loam and its shallow phase are poorly drained. The well-drained soils are free from gray mottling in the surface soils and subsoils. Their surface soils are grayish-brown or brown friable silt loam underlain by light-brown or dark reddish-brown friable plastic clay loam. Surface drainage of these soils ranges from fair to good, and the gravelly substrata, which occur at a depth of about 30 inches, provide good underdrainage.

Homer silt loam may have a porous gravelly substratum lying at a considerable depth, but this soil is not so well drained as the Fox and Bellefontaine soils because of its nearly level surface relief, impervious subsoil, and high water level in the gravelly substratum. The characteristics of Homer silt loam resemble those of Bethel silt loam, from the surface to the underlying stratified clays, sands, and gravel. The characteristics of the shallow phase of Homer silt loam are comparable to those of typical Homer silt loam, except that the subsoil material has more gray mottling and is slightly lighter in texture. At a depth of about 30 inches, this soil is underlain by limestone bedrock which is impervious to water. The Homer soil occurs on terraces, in association with Abington silty clay loam.

The dark-colored soils, including Brookston silty clay loam, Abington silty clay loam, Westland silty clay loam, Clyde silty clay loam, Eel silty clay loam, dark-colored phase, Eel silt loam, and Genesee silt loam, do not have layers of eluviation and illuviation, leaching has not taken place to a great extent, and considerable material has been washed from higher adjacent light-colored soil areas. The dark-colored soils are poorly drained, and in many places, before the land was artificially drained, water covered the surface for long periods. Organic matter decomposed slowly, and many of the areas supported a dense growth of marsh grasses and sedges; consequently, conditions have been favorable for the accumulation of large quantities of organic matter.

Brookston silty clay loam is the dominant dark-colored soil. It occupies the depressions and swales on the flat glacial-till upland and is intimately associated with the Crosby soils.

In a pit one-half mile east of the northwest corner of sec. 25, T. 21 N., R. 12 E., an area of Brookston silty clay loam shows a profile described as follows:

- 0 to 2 inches, black or very dark brown friable structureless silty clay loam.
- 2 to 6 inches, very dark silty clay loam which has a slight crumbly structure but shows no tendency toward definite lines of breakage. When the material is crushed, the color changes to brown.
- 6 to 16 inches, drab or grayish-brown silty clay containing intrusions of organic matter from the layer above. The material has some tendency to break into sharp angular particles.
- 16 to 26 inches, dark-gray clay loam which breaks into sharply angular particles larger than those in the layer above.

26 to 50 inches, yellowish-gray structureless heavy silty clay loam containing a few rocks or pebbles.

50 inches +, similar material to that in the layer above, except that it contains free carbonate of lime.

This soil ranges from neutral to alkaline in reaction throughout the entire profile.

Eel silty clay loam, dark-colored phase, occurs along the shallow stream bottoms in close association with other dark-colored soils. This soil is somewhat similar to Westland silty clay loam. The underlying material consists of assorted sands and clays, but the soil is formed from alluvial deposits. The color of the surface soil varies somewhat, depending on the extent to which the land is subject to overflow. In the deeper stream bottoms and in areas which receive run-off from adjacent light-colored soils, the surface soil is lighter colored than in places where the areas are slightly lower lying and adjacent to bodies of the Brookston soil.

Clyde silty clay loam is the darkest colored soil in the depressions on the glacial-till uplands. It occupies the lowest parts of the depressions and in most places is surrounded by the Brookston soil. The surface soil of the Clyde soil, to a depth of about 10 inches, is black or grayish-brown silty clay loam containing much organic matter. In many places the color of the surface soil is as light as that of the surface soil of the Brookston soil. The greatest difference between the two soils is in the character of their subsoils. The color of the material in the subsoil of Clyde silty clay loam is less yellow, and it contains more gray and rust-brown stains. In some places its color is bluish gray, especially where drainage has been very poor. The subsoil at lower depths is, in most places, high in lime carbonates.

Abington silty clay loam is one of the darkest soils in the county, and it occupies depressions in glacial terraces. These areas were originally poorly drained, but they are now artificially drained. The characteristics of this soil are comparable to those of Clyde silty clay loam, except that the substrata, at a depth of about 40 inches, consist of stratified sands in a clay matrix, which indicates that the material is water-laid. In many areas the Abington soil is mucky and soft from the surface downward.

Westland silty clay loam occupies poorly drained glacial terraces, and it differs from the other dark-colored soils in having a more yellow and friable subsoil. Underdrainage is better, and the subsoil is moderately well aerated, as the color of the material indicates. The substratum material is water-laid and consists of stratified clays, sands, and gravel. The substratum contains more gravel and the water table occurs at a somewhat greater depth than in the substratum of Abington silty clay loam.

Genesee silt loam and Eel silt loam consist of recently deposited alluvium. The bottom land, in which these soils occur, is subject to frequent overflows, and the soils receive comparatively large quantities of fresh alluvium. Genesee silt loam is a well-drained soil occurring along the better drained bottom land where the stream channel has been cut several feet below the surface of the bottom. Its surface soil is brown or light-brown silt loam to a depth of about 6 inches. The subsoil consists of layers of brown material of various textures, owing to deposition of material by flood waters of modern

streams. Eel silt loam also consists of layers of recent alluvium deposited by modern streams. This soil has a light-brown or grayish-brown surface soil overlying a mottled light-gray, brown, and yellow subsoil. As the characteristics indicate, this soil is poorly drained. The materials of these two soils are neutral in reaction.

Table 4 gives the results of determinations of the pH values of Miami silt loam and Crosby silt loam, as determined in the laboratories of the Bureau of Chemistry and Soils by the hydrogen-electrode method.

TABLE 4.—*pH determinations of two soils from Randolph County, Ind.*¹

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Miami silt loam:	<i>Inches</i>		Crosby silt loam:	<i>Inches</i>	
285064.....	Mull	6.5	285010.....	Mull	6.3
285065.....	0-1	6.5	285011.....	0-1	5.8
285066.....	1-3	6.2	285012.....	1-4	5.5
285067.....	3-7	5.1	285013.....	4-8	4.5
285068.....	7-10	4.8	285014.....	8-12	4.8
285069.....	10-14	4.8	285015.....	12-18	4.9
285070.....	14-20	5.0	285016.....	18-24	5.9
285071.....	20-28	6.8	285017.....	24-30	7.9
285072.....	28+	8.2	285018.....	30+	8.2

¹ Determinations made by E. H. Bailey, Bureau of Chemistry and Soils.

MANAGEMENT OF THE SOILS OF RANDOLPH COUNTY ⁴

The farmer should know his soil and have a sound basis for every step in its treatment. Building up the productivity of a soil to a high level, in a profitable way, and then keeping it up is an achievement toward which the successful farmer strives. As in any other enterprise, every process must be understood and regulated in order to be uniformly successful, and a knowledge of the soil is highly important. Different soils present different problems as to treatment, and these must be studied and understood, in order that crops may be produced in the most satisfactory and profitable way.

The purpose of the following discussion is to call attention to the deficiencies of the several soils of the county and to outline in a general way the treatments most needed and most likely to yield satisfactory results. No system of soil management can be satisfactory unless in the long run it produces profitable returns. Some soil treatments and methods of management may be profitable for a time but ruinous in the end. One-sided or unbalanced soil treatments have been altogether too common in the history of farming in the United States.

CHEMICAL COMPOSITION OF RANDOLPH COUNTY SOILS

Table 5 gives the results of chemical analyses of the different types of soil in Randolph County, expressed in pounds of elements in the plowed surface soil of an acre.

⁴ This section of the report was written by A. T. Wiancko and S. D. Conner, Department of Agronomy, Purdue University Agricultural Experiment Station.

TABLE 5.—*Approximate quantities of phosphorus, potassium, and nitrogen per acre of surface soil (6 to 7 inches deep) in Randolph County, Ind., soils*

Soil no.	Soil type	Phosphorus ¹	Potassium ¹	Phosphorus ²	Potassium ²	Nitrogen ³
		Pounds	Pounds	Pounds	Pounds	Pounds
15	Crosby silt loam.....	35	185	980	29,000	3,000
29	Crosby silty clay loam.....	35	170	1,150	37,000	2,800
57	Bethel silt loam.....	35	120	975	28,000	2,400
32	Homer silt loam, shallow phase.....	55	135	960	28,000	2,800
2	Miami silt loam.....	35	135	980	32,000	2,600
23	Miami silt loam, level phase.....	55	150	1,250	30,000	3,600
6	Miami silty clay loam.....	35	200	1,225	35,000	2,800
40	Bellefontaine silt loam.....	70	150	1,300	30,000	3,000
8	Fox silt loam.....	60	170	1,575	31,000	3,000
21	Brookston silty clay loam.....	190	285	1,925	38,000	4,600
26	Westland silty clay loam.....	115	185	1,750	34,000	5,800
35	Clyde silty clay loam.....	315	320	2,185	32,000	7,200
20	Abington silty clay loam.....	245	370	2,140	33,000	7,600
14	Genesee silt loam.....	200	235	1,575	32,000	5,200
10	Eel silt loam.....	165	220	1,750	28,000	4,400
28	Eel silty clay loam, dark-colored phase.....	120	280	1,750	40,000	5,000
11	Wallkill silty clay loam.....	80	170	1,400	32,000	3,200
60	Carlisle muck.....	135	85	1,875	6,000	21,600

¹ Soluble in weak nitric acid (fifth normal).² Soluble in strong hydrochloric acid (specific gravity 1.115).³ Total elements.

The analyses give the pounds of phosphorus and potassium soluble in weak (fifth normal) nitric acid, the pounds of phosphorus soluble in strong hydrochloric acid (specific gravity 1.115), the pounds of total potassium, and the pounds of total nitrogen.

The amount of phosphorus soluble in weak nitric acid is considered by many authorities a very good indication of the relative availability of this element. Where the weak-acid soluble phosphorus runs less than 100 pounds to the acre, phosphates are usually needed for high crop yields. The more intensive the crop, the greater is the need for large quantities of available phosphorus. Everything else being equal, the more weak-acid soluble phosphorus a soil contains, the less it is apt to need phosphates. The deeper the soil, the less it needs phosphates. Subsoils contain less available phosphorus than surface soils. A soil which has had the surface layer eroded, exposing the subsurface layers, is apt to be in need of phosphates.

The quantity of potassium soluble in weak acid is considered by some authorities significant of the need of a soil for potash. This determination, however, is not so certain an indicator as is that for phosphorus. In general, however, the lower the soluble potassium, the greater is the need for potash. The potassium of the subsoil is fairly available, and potash is more apt to be needed on flat uneroded land than on sloping eroded soils. Sandy soils and muck soils are more often in need of potash than clay and loam soils. Poorly drained soils and soils with impervious subsoils usually need potash more than well-aerated deep soils.

The strong-acid soluble phosphorus, the total potassium, and nitrogen are given as an indication of the plant-nutrient content of the soil. The total amounts of phosphorus and potassium are more valuable as an indication of the origin of the soil than they are of the need of the soil for these elements, as much of the phosphorus and potassium in soils is very insoluble and extremely slow in avail-

ability. The total content of nitrogen is to a great extent indicative of the nitrogen and organic-matter content of the soil. Soils of low nitrogen content soon wear out, and this and other plant-nutrient elements should be replenished by legumes, manure, and fertilizer. The darker the soil the higher it is in organic matter and nitrogen and the longer it may be cropped without the use of nitrogenous fertilizer.

No one method of soil analysis will definitely indicate the deficiencies of a soil. For this reason these chemical data are not intended to be the sole guide in determining the needs of the soil. The depth of the soil, the physical character of the horizons of the soil profile, and the previous treatment and management of the soil are all factors of the greatest importance and should be taken into consideration. Pot tests indicate that nitrogen and phosphorus are much less available in the lower layers of soil than they are in the surface soils. On the other hand, potassium in the subsoil seems to be of relatively high availability. Crop growth depends largely on the amount of available plant nutrients with which the roots may come in contact. If the crop can root deeply, it may be able to make good growth on soils of relatively low analysis. If the roots are shallow, the crop may suffer for lack of food, particularly potash, even on a higher analysis soil. The better types of soils and those containing large amounts of plant-nutrient elements will endure exhaustive cropping much longer than the soils of low plant-nutrient content.

The nitrogen, phosphorus, and potassium contents of a soil are not the only chemical indications of high or low fertility. One of the most important factors in soil fertility is the degree of acidity. Very acid soils will not produce well, even though there be no apparent lack of plant-nutrient elements. Although nitrogen, phosphorus, and potassium are of some value when added to acid soils, they will not produce their full effect where lime is deficient. This is particularly true of phosphorus. Table 6 shows the percentage of nitrogen and the acidity of the various soils in Randolph County. The acidity is expressed as pH, or intensity of acidity. A soil of pH 7 is neutral and contains just enough lime to neutralize the acidity. If the pH is more than 7, it means that there is some excess of carbonate of lime. From pH 6 to pH 7 indicates slightly acid soils and from pH 5 to pH 6 soils of medium acidity. If the pH runs below 5, the soil is strongly acid. As a rule, the stronger the acidity the more a soil needs lime.

The acidity is reported for the surface soil (0 to 6 inches), for the subsurface soil, and for the deeper subsoil. It is important to know the reaction not only of the surface soil but of the lower layers of the soil as well. Given two soils of the same acidity, the one with the greater acidity in the subsurface layer is in greater need of lime than the other. The less the depth of acid soil, the less apt it is to need lime. Those soils having the greater clay content will need a greater amount of lime to neutralize them, given the same degree of acidity. It is well to remember that sweetclover, alfalfa, and red clover need lime more than other crops. As it is advisable to grow these better soil-improvement legumes in the rotation, it is in many places desirable to lime the land so that sweetclover or

alfalfa will grow. A soil ranging from pH 7 to pH 8 is ideal for these legumes. Grain crops do well on slightly acid soils.

TABLE 6.—Percentage of nitrogen in and acidity of Randolph County, Ind., soils

Soil no.	Type of soil	Depth	Nitrogen	pH	Average depth to neutral material	Indicated lime requirement per acre
		<i>Inches</i>	<i>Percent</i>		<i>Inches</i>	<i>Tons</i>
15	Crosby silt loam	0-6	0.15	7.0	21	0-2
		6-18	.08	5.6		
		18-30	.05	7.0		
29	Crosby silty clay loam	0-6	.14	7.0	15	0-2
		6-14	.08	6.0		
		14-30	.05	8.0		
57	Bethel silt loam	0-6	.12	6.9	21	0-2
		6-16	.07	5.8		
		16-36	.05	6.5		
32	Homer silt loam, shallow phase	0-6	.14	7.0	21	0-2
		6-16	.08	6.2		
		16-36	.04	6.8		
2	Miami silt loam	0-6	.13	6.5	22	0-2
		6-14	.07	5.3		
		14-30	.05	7.4		
23	Miami silt loam, level phase	0-6	.18	7.0	30	0-2
		6-18	.08	7.4		
		18-30	.06	5.4		
6	Miami silty clay loam	0-6	.14	7.5	16	0-2
		6-18	.08	6.5		
		18-24	.05	7.8		
40	Bellefontaine silt loam	0-6	.15	7.4	24	0-2
		6-15	.09	7.0		
		15-28	.06	6.4		
8	Fox silt loam	0-6	.15	6.6	26	0-2
		6-15	.08	6.5		
		15-30	.05	6.2		
21	Brookston silty clay loam	0-6	.23	7.4	0	None
		6-15	.18	6.7		
		15-24	.10	7.3		
26	Westland silty clay loam	0-6	.29	7.2	0	None
		6-18	.21	7.4		
		18-28	.10	7.5		
35	Clyde silty clay loam	0-8	.36	7.6	0	None
		8-18	.20	7.6		
		18-36	.07	7.8		
20	Abington silty clay loam	0-6	.38	7.6	0	None
		6-18	.23	7.6		
		18-34	.08	7.6		
14	Genesee silt loam	0-6	.26	7.5	0	None
		6-25	.20	7.3		
		25-36	.16	7.5		
10	Eel silt loam	0-6	.22	7.9	0	None
		6-18	.11	7.8		
		18-30	.06	7.8		
28	Eel silty clay loam, dark-colored phase	0-6	.25	7.5	0	None
		6-14	.18	7.5		
		14-28	.08	7.5		
11	Walkkill silty clay loam	0-7	.16	7.0	0	None
		7-14	1.17	6.7		
		14-30	1.80			
60	Carlisle muck	0-9	2.16	6.9	0	None
		9-20	1.80	7.2		
		20-36	1.75	7.8		

In interpreting the soil survey map and soil analyses, it should be borne in mind that a well-farmed, well-drained, well-fertilized, well-manured soil which is naturally low in fertility may even produce larger crops than a poorly farmed soil naturally higher in fertility.

SOIL MANAGEMENT

For convenience in discussing the management of the several soils of this county, they have been arranged in groups according to certain important characteristics which indicate that in many respects

similar treatment is required. For example, several of the light-colored upland soils, which have practically the same requirements for their improvement, may be conveniently discussed as a group, thus avoiding the repetition that would be necessary if each were discussed separately. Where different treatments are required these are specifically pointed out. The reader should study the group including the soils in which he is particularly interested.

LIGHT-COLORED SOILS OF THE UPLANDS AND TERRACES

The group of light-colored soils of the uplands and terraces includes the silt loams of the Crosby, Miami, Fox, Bethel, Homer, and Bellefontaine series, named in order of their importance; and the silty clay loams of the Crosby and Miami series, also named in order of importance. Crosby silt loam is the most extensive light-colored soil in the county, occupying 25.7 percent of the total area. Crosby silty clay loam occupies 19.9 percent, Miami silt loam, with two phases, 11.5 percent, Miami silty clay loam 5.7 percent, Fox silt loam 0.9 percent, Bethel silt loam 0.5 percent, Homer silt loam, with a shallow phase, 0.2 percent, and Bellefontaine silt loam 0.2 percent. The combined acreage of the soils of this group is 64.6 percent of the total area of the county.

All these soils are naturally deficient in phosphorus, nitrogen, and organic matter, and systems of soil management should be especially concerned with economical means of building up the supplies of these substances and constantly replenishing the losses incident to crop production. These soils are in general deficient in available potash, and some do not contain enough lime, especially in the upper part of the subsoils of the Miami, Crosby, and Bethel silt loams. Therefore, some liming may be necessary, especially for the Crosby and Bethel soils.

DRAINAGE

The Bellefontaine, Fox, and Miami soils have fair or good natural drainage, although the heavier and more level areas of the Miami soils would be benefited by some tile drainage. Wherever there is a tight or heavy subsoil, tile drainage would be beneficial, as without underdrainage erosion of the surface soil is more apt to occur. Surface run-off should be prevented as much as possible because it carries away large quantities of available plant nutrients which should go into the production of crops. Rain water should be absorbed by the soil, and the surplus should pass away through underdrainage. Tile drainage increases the capacity of heavy soils to absorb water and thus lessens surface run-off and consequent erosion. It also facilitates soil aeration, which helps to render available the plant nutrients in the soil, and it encourages deeper rooting of crops, which enables them to better withstand drought, as well as to obtain more plant nutrients.

The Bethel, Homer, and Crosby silt loams and Crosby silty clay loam are naturally poorly drained and are more or less seriously in need of tile drainage. Their generally flat surface relief retards run-off, and their tight subsoils make natural underdrainage very slow and difficult. A gray or mottled subsoil is always an indication of insufficient natural drainage. Without tile drainage these soils

cannot be satisfactorily managed and no other beneficial soil treatment can produce its full effect. Results on experiment fields on other soils of similar texture and surface relief indicate that tile lines laid 30 inches deep and not more than 3 rods apart will give satisfactory results. Where the land is very flat, great care must be exercised in tiling, in order to obtain an even grade and uniform fall. Grade lines should not be established by guess or by rule-of-thumb method. Nothing less accurate than a surveyor's instrument should be used, and the lines should be accurately staked and graded before the ditches are dug, to make sure that all the water will flow to the outlet with no interruption or slackening of the current. The rate of fall may be increased toward the outlet, but it should never be decreased without inserting a silt well, as checking the current may cause the tile to become choked with silt. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with straw, weeds, or grass. This prevents silt from washing into the tile at the joints while the ground is settling, thus insuring perfect operation of the drains from the beginning.

LIMING

Although there are no very acid soils in this county, many individual areas will respond profitably to some liming. A strong indication of the need of liming is the failure of clover to do well on land that is otherwise in a fair state of fertility. However, the need for liming is so easily determined that tests should be made in each particular case. If the farmer himself cannot make the test, he should have it made by the county agricultural agent or by the agricultural experiment station at La Fayette. Ground limestone is the most economical form of lime to use in most places. Where liming is needed, the first application should, as a rule, be about 2 tons to the acre. After that a ton to the acre every second or third round of the crop rotation will keep the soil in good condition for most crops. Where alfalfa or sweetclover is to be grown on acid soil, heavier applications of lime may be needed.

ORGANIC MATTER AND NITROGEN

With the exception of some small areas of Fox silt loam, the soils of this group are naturally low in nitrogen and organic matter. Where the land has been cropped for some time without adequate returns of organic material matters have been made worse, and in many places the original supplies of organic matter have become so reduced that the soil has lost much of its natural mellowness, and it easily becomes puddled and baked. This condition, in large measure, accounts for the more frequent clover failures and the greater difficulty in obtaining proper tilth in such areas.

Wherever these evidences of lack of organic matter and nitrogen occur, the only practical remedy is to plow under more organic matter than is used in the processes of cropping. Decomposition is constantly going on and is necessary in order to maintain the productivity of the soil. Decomposing organic matter must also supply the greater part of the nitrogen required by crops. For this reason legumes should provide as much as possible of the organic matter to

be plowed under. To do this satisfactorily, the land must first be put in condition to grow clover and other legumes. This means liming wherever the soil is acid. Wet lands must also be tile drained. Clover or some other legume should appear in the rotation every 2 or 3 years; as much manure as possible should be made from the produce that can be utilized by livestock; and all produce not fed to livestock, such as cornstalks, straw, and cover crops, should be plowed under directly. It must be remembered that legumes are the only crops that can add appreciable quantities of nitrogen to the soil, and then only in proportion to the amount of top growth that is plowed under, either directly or in the form of manure. Wherever clover-seed crops are harvested, the haulm should be returned to the land and plowed under. Cover crops should be grown wherever possible to supply additional organic material for plowing under. Seeding rye as a cover in September on cornland that is to be plowed the following spring is good practice for increasing organic matter and conserving nitrogen. It is important to have some kind of a growing crop on these soils during the winter, in order to take up the soluble nitrogen which would otherwise be lost through leaching. Without living crop roots to take up the nitrates from the soil water, large losses will occur between crop seasons through drainage, and there will also be more soil erosion on slopes and hillsides. Both of these losses may be greatly lessened by a good cover crop of winter rye on all land that would otherwise be bare during the winter. The rye should be run down with a heavy disk and plowed under before heading.

CROP ROTATION

With proper fertilization, and liming and tile drainage where needed, these soils will satisfactorily produce all the ordinary crops adapted to the locality. On account of the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume to be returned to the land in one form or another. Corn, wheat, or oats and clover or mixed clover, alfalfa, and timothy constitute the best short rotation for general use on these soils, especially when the corn can be cut and the ground can be disked and properly prepared when wheat is the small-grain crop to follow. Corn, soybeans, wheat or oats, and mixed hay constitute an excellent 4-year rotation for these soils. The two legumes in the rotation will build up the nitrogen supply. When the soybean is first introduced, the seed should be carefully inoculated with the proper variety of nitrogen-gathering bacteria, and this inoculation should be applied at least 2 years in succession. The soybean straw, if not used as feed, should be spread on the wheatland in the winter. This will not only help the wheat and lessen winter injury, but it will help to insure a stand of clover or other seeding for the hay crop. The soybean is not only a good crop in itself, but it also adds some nitrogen to the soil and improves it for the crop that follows. If more corn is wanted, as on livestock farms, the 5-year rotation of corn, corn, soybeans, wheat or oats, and mixed hay may be used satisfactorily where the second corn crop can be given a good dressing of manure. Where corn follows corn, as in the 5-year rotation, and where soybeans follow corn, as in both the 4-year and 5-year rotations suggested, cover crops of sweetclover or rye, for plowing

under the following spring, should be seeded in each corn crop to help maintain fertility. Where, owing to climatic conditions, clover is uncertain in any of these rotations, it has proved to be a good plan to sow a mixture of seeds made up of about 3 pounds of red clover, 4 pounds of alfalfa, 1 pound of alsike, and 1 pound of timothy to the acre. Alfalfa is more drought resistant than clover, and alsike and timothy are more acid tolerant. Since the red clover and alfalfa are the more valuable constituents of the mixture, conditions for their growth should be made as favorable as possible by liming soils that are acid, by maintaining a good physical condition through frequent incorporations of organic matter, and by providing proper drainage.

Alfalfa and sweetclover may be grown as special crops on most of these soils. As a rule the Miami, Fox, and Bellefontaine soils are better adapted to these crops than the Crosby, Homer, or Bethel, which are typically more acid and in many places too wet for the best development of these deep-rooted legumes. In this part of the State, however, many areas of these soils show little or no acidity and may be satisfactorily used for alfalfa or sweetclover with little or no liming if provided with adequate drainage. Alfalfa is preferable for hay, and sweetclover is excellent for pasture and for soil-improvement purposes. Lespedeza is an acid-tolerant legume especially valuable in pastures, because it makes most of its growth after midsummer when pure grass pasture is usually at a low point in carrying capacity. Special literature on the cultural requirements of alfalfa, sweetclover, and lespedeza may be obtained from the Purdue University Agricultural Experiment Station at La Fayette.

FERTILIZATION

All the soils of this group are naturally low in phosphorus, and the available supplies of this element are so low that the phosphorus required by crops should be largely supplied in applications of manure and commercial fertilizers. The nitrogen supplies in these light-colored soils are also too low to satisfactorily meet the needs of corn, wheat, oats, and other nonleguminous crops, and provisions for adding nitrogen should be an important part of the program for their improvement. The total quantities of potassium in these soils are large, but the available supplies, especially in the surface soil, are generally low, and in most places the addition of some potash fertilizer would be profitable, especially where little manure is applied.

The problem of supplying nitrogen has been discussed in connection with provisions for supplying organic matter. Legumes and manure are the logical and only really practical means of supplying the greater part of the nitrogen needed by crops, and they should be largely relied on for this purpose. A livestock system of farming, with plenty of legumes in the crop rotation, is, therefore, best for these soils. However, it will generally pay to have some nitrogen in the fertilizer for wheat, regardless of its place in the rotation. Even though wheat follows soybeans or other legumes, it should receive some nitrogen in the fertilizer applied at seeding time to start the crop properly, because the nitrogen in the residues of these legumes does not become available quickly enough to be of much help to the wheat in the fall. The material must first decay, and that does not take place to any great extent until the following spring.

Phosphorus is the mineral plant-nutrient element in which all these soils are most deficient. The only practical way to increase the supply is through the application of purchased phosphatic fertilizers, and it will prove profitable to supply the entire phosphorus needs of crops in this way. In rotations of ordinary crops, producing reasonable yields, it may be counted that 20 pounds of available phosphoric acid to the acre are required each year. It will pay well to apply larger quantities at first, so as to create a little reserve. Enough for the entire rotation may be applied at one time, or the application may be divided according to convenience. Where manure is applied, it may be counted that each ton supplies 5 pounds of phosphoric acid; therefore a correspondingly smaller quantity need be provided in the form of commercial fertilizer.

On the soil-fertility experiment field on the Herbert Davis Forestry Farm, belonging to Purdue University and located on Crosby silty clay loam in this county (pl. 2), highly profitable returns have been obtained wherever available phosphate has been applied. During the 10 years since this experiment was begun, applications of 75 pounds to the acre of 16-percent superphosphate in the row for corn and 225 pounds for wheat in a corn, wheat, and clover rotation, have produced crop increases averaging 8.1 bushels of corn, 9.3 bushels of wheat, and 561 pounds of hay to the acre, at a cost of \$3.60 for the phosphate. Manure applied for corn at the rate of 6 tons to the acre has produced crop increases averaging 9.8 bushels of corn, 3.6 bushels of wheat, and 245 pounds of hay. But manure alone is not sufficient to produce the most profitable returns. On land receiving 6 tons of manure to the acre, 225 pounds of superphosphate applied for wheat only has increased the crop yields over manure alone by 3.4 bushels of corn, 7.2 bushels of wheat, and 375 pounds of hay (pl. 3). These experiments demonstrate the importance of using liberal applications of phosphate on this type of soil, both with and without manure. Where manure is not available, a good complete fertilizer should be used for wheat and a phosphate-potash mixture for corn. On this experiment field, applications of 300 pounds to the acre of a 2-12-6⁵ fertilizer for wheat have produced crop increases averaging 10.5 bushels of wheat and 508 pounds of hay. One hundred pounds of 0-12-6 fertilizer in the row for corn has produced an average increase of 8.2 bushels an acre.

The quantity of potash that should be applied as fertilizer depends on the general condition of the soil and the quantity of manure used. The flat poorly drained areas of the gray soils are the ones most likely to be in need of potash fertilizer. On soils that have become run down, any program for their improvement should include potash fertilizer, at least until such time as considerable quantities of manure can be applied or until the general condition of the soil has materially improved. Although large total supplies of potassium are present in these soils, the readily available potash is low in many places. Its availability may be increased by good farm practices, including proper tillage, tile drainage, the growing of deep-rooted legumes, and the plowing under of liberal quantities of or-

⁵ Percentages, respectively, of nitrogen, phosphoric acid, and potash.

ganic matter. The better these practices are carried out and the larger the quantity of manure applied, the less potash fertilizer need be purchased.

In the fertilization of these soils, the manure should usually be plowed under for the corn crop, but a part, about 2 tons to the acre, may be applied profitably on wheat as a top-dressing during the winter. Such use of a part of the manure not only helps the wheat and lessens winter injury but also helps to insure a stand of clover or other crop seeded in the wheat. As a rule, the manured corn should also receive some available phosphate in the hill or row at a rate ranging from 75 to 100 pounds to the acre. Without manure, a phosphate and potash mixture may be preferable. Wheat should always be given from 200 to 300 pounds to the acre of a high-analysis complete fertilizer, such as a 2-12-6 mixture at seeding time. A top-dressing ranging from 15 to 20 pounds of soluble nitrogen, applied in April when the wheat is 2 or 3 inches high, may be expected to cause an increase of 5 or 6 bushels to the acre. Where properly fertilized corn and wheat are included in the rotation, there will be little need for fertilizer on other crops. Oats and soybeans, as a rule, will not give much response to direct applications of fertilizer.

DARK-COLORED SOILS OF THE UPLANDS AND TERRACES

The group of dark-colored soils of the uplands and terraces is made up of silty clay loams of the Brookston, Clyde, Abington, Westland, and Walkill series. With the exception of the Walkill, these are the most fertile soils of the county. They are interspersed with light-colored soils having similar topographic positions. They occupy the depressions—the Brookston and Clyde in the uplands, and the Abington and Westland on the terraces. Walkill silty clay loam is a very inextensive soil occupying only a few small areas. It overlies muck and is generally deficient in potash. Together, these dark-colored soils occupy 84,992 acres, or 29.7 percent of the total area of the county. Brookston silty clay loam accounts for 26.1 percent, or almost 75,000 acres.

The soils of this group are the most fertile in the county. They are naturally well supplied with organic matter and nitrogen, contain fair supplies of available phosphorus and potassium, and are sufficiently sweet that there is no immediate need for liming.

DRAINAGE

All these soils are more or less in need of artificial drainage. Their dark color indicates a swampy origin where natural drainage was poor. Where more drainage is needed, the same procedure should be followed as that suggested for the light-colored silty clay loam soils.

ORGANIC MATTER AND NITROGEN

For the most part, these soils are naturally sufficiently well supplied with organic matter and nitrogen to meet the needs of most crops, and with reasonable care in their management no special provisions for supplying these constituents will be necessary for a long time. However, on much of the Brookston soil, at least, crop residues should not be wasted and some cover crops may also be used

to advantage. Some of the areas of heavier soil will be easier to handle if rather large quantities of organic matter are worked in.

CROP ROTATION

After proper drainage has been provided, these soils are among the best in the county and will produce all the ordinary crops adapted to the region. They are especially well suited to corn, and this should be the major crop in most places. Among the rotations that may be satisfactorily employed are the following: Corn, wheat or oats, and clover; corn, corn, wheat or oats, and clover; corn, soybeans, wheat or oats, and clover; and corn, corn, soybeans, wheat or oats, and clover. To guard against the hazards of winter-killing of clover, it is generally advisable to seed some timothy and alsike with the red clover. These soils are also adapted to alfalfa and sweetclover where sufficient drainage has been provided. Whenever clover fails, the soybean makes a satisfactory substitute crop for legume hay.

FERTILIZATION

These soils are naturally fairly well supplied with nitrogen, and with legumes in the crop rotation the fertilizer need not contain nitrogen for the ordinary field crops, except for wheat. Corn should generally receive some available phosphate in addition to manure. On farms having both light-colored and dark-colored soils, the manure should be applied to the light-colored soil in which the organic matter and nitrogen of the manure are most needed. Wheat should always receive a good complete fertilizer, such as a 2-12-6, to start it properly in the fall. Without manure, considerable amounts of commercial fertilizer will be profitable. Corn should receive from 75 to 100 pounds to the acre of superphosphate or of a phosphate and potash mixture in the hill or row, and wheat should receive from 200 to 300 pounds of a complete fertilizer. Such fertilization will also provide for the needs of the clover crop. Oats will seldom respond to nitrogen in fertilizer, and where this is the small-grain crop a phosphate and potash mixture will generally be sufficient.

MUCKS

Muck includes all the highly organic soils of the county. It occurs in several small bodies and two larger areas including between 50 and 75 acres each. The combined areas of muck amount to 0.1 percent of the total area of the county. The muck is of the nonacid type and does not require liming. The profitable management of muck involves the following points: Careful drainage, the growing of suitable crops, and the application of large quantities of potash. In most places some phosphate also will be profitable, especially after the land has been cropped for several years. The potash fertilizer needs are especially urgent on the typical muck areas, which are naturally very low in both total and available potassium. The more silty muck is much better supplied with both phosphorus and potassium and may not require much fertilizer for some time.

The question is sometimes asked if muck soils can be improved by burning. They cannot be permanently improved by burning, and they may be seriously injured. Burning adds nothing; on the other



Effects of lime, manure, and phosphate on yields of corn and wheat. The crop rotation is corn, wheat, and clover. All the land was limed in 1923. The fertilization consists of 6 tons of manure to the acre for corn and 225 pounds of 20 percent superphosphate for wheat. Average yields an acre, 1924-33: *A, a*, Lime alone, 39.3 bushels; *b*, lime and manure, 49.1 bushels; *c*, lime, manure, and phosphate, 52.5 bushels. *B, a*, Lime alone, 12.9 bushels; *b*, lime and manure, 16.5 bushels; *c*, lime, manure, and phosphate, 23.7 bushels.

hand it destroys much valuable organic matter and nitrogen. The mineral plant-nutrient elements concentrated in the ash remains are not to be considered as gain, as these elements are soon exhausted and the land is left in a poorer condition than it was before burning, because of the destruction of organic matter and the consequent lowering of the land level to such an extent, in many places, as to make drainage more difficult.

DRAINAGE

In improving muck soils, the first requisite is proper drainage. As a general rule the water table should be lowered to a depth ranging from 30 to 40 inches below the surface, but not more than 4 feet. For meadows, a depth of 2 feet to the water table may be enough for best results. Most of the muck lands will drain freely if the water has a chance to get away. It is not necessary that ditches and tile lines be so close together as in the fine-textured soils. Ordinarily, the distance between tile lines or lateral ditches should be about 100 feet. Whether tile or open ditches should be used depends on local conditions. If the subsurface material is sufficiently firm to hold tile in place, tiling is to be preferred, since open ditches are always a nuisance. In extensive areas, large open outlet ditches may be necessary to keep the water table at a proper level to meet the needs of crops.

Most muck areas receive considerable surface water and seepage water from the higher lands adjoining, and the plan of drainage should provide for the removal of such waters as well as the excess water that falls on these areas. The first thing to be done is to cut a ditch or lay a line of tile along the edge of the marsh next to the higher land adjoining. This will catch the seepage from the higher land and make drainage of the rest of the muck area comparatively easy.

It has been stated that muck soils should not be too deeply drained, because the crops grown on them are apt to suffer from lack of water. However, where tile drainage is used, the lines of tile must be placed sufficiently deep that subsequent settling of the soil will not leave them too near the surface, as muck settles considerably within the first few years after drainage, and allowance for this should be made. The tile should be laid from 3½ to 4 feet below the surface, unless the muck is already well settled, owing to several years of drainage with open ditches. The aim should be, ultimately, to have the water table at a depth of about 3 feet below the surface. Great care should be exercised in establishing an even grade for each line of tile, so that the flow of water will be uniform. Fine materials which wash in at the tile joints settle easily and will soon clog the tile if the grade line is uneven. As a rule, nothing smaller than 5-inch tile should be used for muck soils. It is a good plan to cover the tile with a few inches of straw or grass before filling the ditches. This will keep much fine material out of the tile while the ground is settling.

In some places it may be desirable to raise the water table when the dry season of the year approaches, especially for shallow-rooted crops. This can be done by temporarily damming up the outlets of the ditches or by blocking the tile outlets, thus holding the water table up until sufficient rains come again.

FERTILIZATION

In the fertilization of muck soils, potash is of first importance. Nitrogen is present in great abundance; hence the addition of nitrogenous fertilizers is not required, except for early truck crops which need quickly available nitrogen, especially in late seasons when nitrification, the bacterial action which makes nitrogen available, does not begin sufficiently early to supply these crops. For the grain and hay crops, the natural soil supplies of nitrogen become available fast enough to meet all needs. Some mucks when first brought under cultivation may produce a few good crops without the addition of potash, but the available potassium soon becomes exhausted and the only recourse is to supply this element from outside sources. The more silty muck is much better supplied with potash, and the phosphorus supplies are fair to begin with.

For the common field crops, about 100 pounds of muriate of potash to the acre should be applied each year, or 200 pounds every other year. In many places especially after several years of cropping, it will pay to add some available phosphate, and a fertilizer, such as 0-8-24, may be desirable.

For truck crops the rate of applying fertilizer should be much greater than for grain crops. For celery some growers use as much as 2,000 pounds of fertilizer to the acre. For early-planted crops, such as onions, lettuce, and cabbage, large quantities of complete fertilizer, as 3-9-18, are used by many farmers.

Farm manure may be used to supply potassium and phosphorus to these soils; however, on farms including both organic and mineral soils the manure should preferably be applied to the mineral soils, because the organic soils do not need the nitrogen and organic matter it supplies, whereas the mineral soils especially need these constituents. In some places the application of manure on raw muck soils will be helpful in supplying beneficial bacteria which may be lacking, especially if the material is very raw or the land has always been very wet.

CROPS FOR MUCK SOILS

Muck soils, when properly drained and fertilized, may be satisfactorily used for all the field and garden crops adapted to the climatic conditions of the region, including many crops not adapted to the common upland soils. Most of the truck and small garden crops will do better on properly managed organic soils than on mineral soils. It may be said, therefore, that the farmer who has muck soil has a much greater range in the choice of crops that he may grow.

For the general farmer, corn is the best crop for muck soils, as these soils can endure cropping with corn longer than any other soil, except rich overflow bottom lands. With the addition of plenty of potash and some phosphate, corn may be grown on muck fields most of the time. It is necessary, however, to use early varieties of corn in order to escape early frosts. For a change in the cropping system, such crops as soybeans, rye, and mixed timothy and alsike for meadow or pasture are suggested. Potatoes also may be fitted into the rotation.

On the Pinney-Purdue muck experiment field near Wanatah, in La Porte County, a 4-year rotation of corn, corn, soybeans, and

potatoes is giving good results. During the 9 years since this experiment was begun, the crops grown under this rotation, together with proper fertilization of the land, have averaged 51 bushels of corn, 24 bushels of soybeans, and 149 bushels of potatoes to the acre. The fertilizer used is 0-8-24, applied at the rate of 150 pounds to the acre in the row for corn and 300 pounds for potatoes. On a part of this field, where the quantity of potash was doubled, the average yield of potatoes has been increased to 174 bushels, but increases of the other crops have been small, averaging 4 bushels of corn and 2 bushels of soybeans.

The small grains are the least suitable crops for muck soils because they are apt to produce a rank growth of weak straw and lodge badly. Liberal applications of potash will aid materially in producing stiffer straw. Other crops adapted to muck soils are mint, hemp, Sudan grass, millet, sorghum, buckwheat, sugar beets, turnips, and mangels. Of the truck crops, onions, cabbage, cauliflower, kale, rutabagas, celery, lettuce, parsnips, beets, and carrots do well on this kind of land.

IMPORTANCE OF COMPACTING MUCK SOILS

One of the difficulties in managing muck soils is that they are apt to be too loose on the surface. In preparing the seed bed, therefore, it is important to pack the ground thoroughly by the use of a heavy roller, going over the field several times if necessary. Thorough compacting of the muck is not only better for crop growth, but it also aids materially in lessening the danger of early frosts.

BOTTOM LANDS

The bottom lands of Randolph County consist of Genesee silt loam, Eel silt loam, and a dark-colored phase of Eel silty clay loam, which together constitute 5.5 percent of the total area. Genesee silt loam predominates.

The greatest difficulty in the management of these soils is to provide adequate drainage and to prevent damage from flooding. The heavier areas should be tiled wherever suitable outlets can be provided, in order that surplus water may drain away more readily. With the exception of a few light-colored spots, these soils are reasonably well supplied with organic matter and nitrogen. A light color of the soil indicates lack of these constituents, and in such areas provision should be made for increasing the organic matter and nitrogen supplies by manuring and by incorporation into the soil of other organic materials, such as crop residues and especially grown cover crops or intercrops. Liming is not required.

Most of this land, when brought under cultivation, is best adapted to corn, but wherever excess water is not troublesome some other crop, such as wheat, oats, clover, and soybeans, should occasionally be included in the cropping system. On certain areas not damaged by flooding, alfalfa and some truck crops also will do well.

Most of this land receives rich sediments from periodic overflows of the streams and hence requires little fertilizer. The poorer areas, however, will respond to applications of available phosphates and potash. For truck crops, the use of some nitrogen also will prove profitable.

SUMMARY

Randolph County is in the middle-eastern part of Indiana, adjoining Ohio. It is nearly square, and its total area is 447 square miles, or 286,080 acres.

Most of the county is an undulating plain, with local differences in elevation in few places exceeding 20 feet. Along the larger sloughs or valleys and terminal moraines the relief is greater, particularly in the southern part of the county. The land slopes toward Mississinewa, Whitewater, White, and Stillwater Rivers.

The main physiographic features are glacial uplands, glacial river terraces, or outwash plains, and recent-alluvial bottoms.

Sixteen soil types and four phases are mapped. All the soils are favorable for agricultural practices.

The 16 soil types are grouped in 2 large divisions, based on the color of their surface soils. In one division are the light-colored soils and in the other, the dark-colored soils.

Natural drainage of the light-colored soils ranges from good to imperfect. The organic-matter content is low, which necessitates some care in management, in order to maintain productivity. These soils are generally acid in the surface soils and upper subsoil layers, but alkaline (calcareous) in the lower subsoil layers. Clover can be grown on most of them without previous treatment with lime.

Most of the dark-colored soils have poor natural drainage. They contain considerable quantities of organic matter, are naturally fertile, nearly neutral in reaction, and everywhere a stand of clover can be obtained without previous treatment with lime.

The Crosby and Miami soils, the dominant light-colored soils, are intimately associated on the upland with the dark-colored Brookston silty clay loam and Clyde silty clay loam. Natural drainage of the Miami soils is good, but that of the Crosby soils is slow or imperfect.

Bethel silt loam and Homer silt loam, shallow phase, have the poorest natural drainage of the light-colored soils. Bethel silt loam is closely associated with the Crosby soils and with Brookston silty clay loam.

Bellefontaine silt loam and Fox silt loam are underlain by calcareous gravel. These soils are characterized by good internal drainage. They produce favorable crop yields. Their subsoils are comparatively heavy textured and retentive of moisture.

Miami silt loam, level phase, resembles the other Miami soils except it has a browner color and has better internal drainage. It is underlain by gravel at a depth of about 8 feet.

Brookston silty clay loam and Clyde silty clay loam are the dominant dark-colored soils. They occupy depressions on the upland and have poor natural drainage. Abington silty clay loam and Westland silty clay loam differ from the Clyde and Brookston soils chiefly in their occurrence on terraces or in old valleys and in having gravel in the lower part of the subsoil.

The soils developed from alluvium are classed as Genesee and Eel soils. The well-drained bottom-land soil having a brown surface is mapped as Genesee silt loam, and the less perfectly drained bottom-land soil is classified as Eel silt loam.

The miscellaneous soil types are Carlisle muck and Wallkill silty clay loam.

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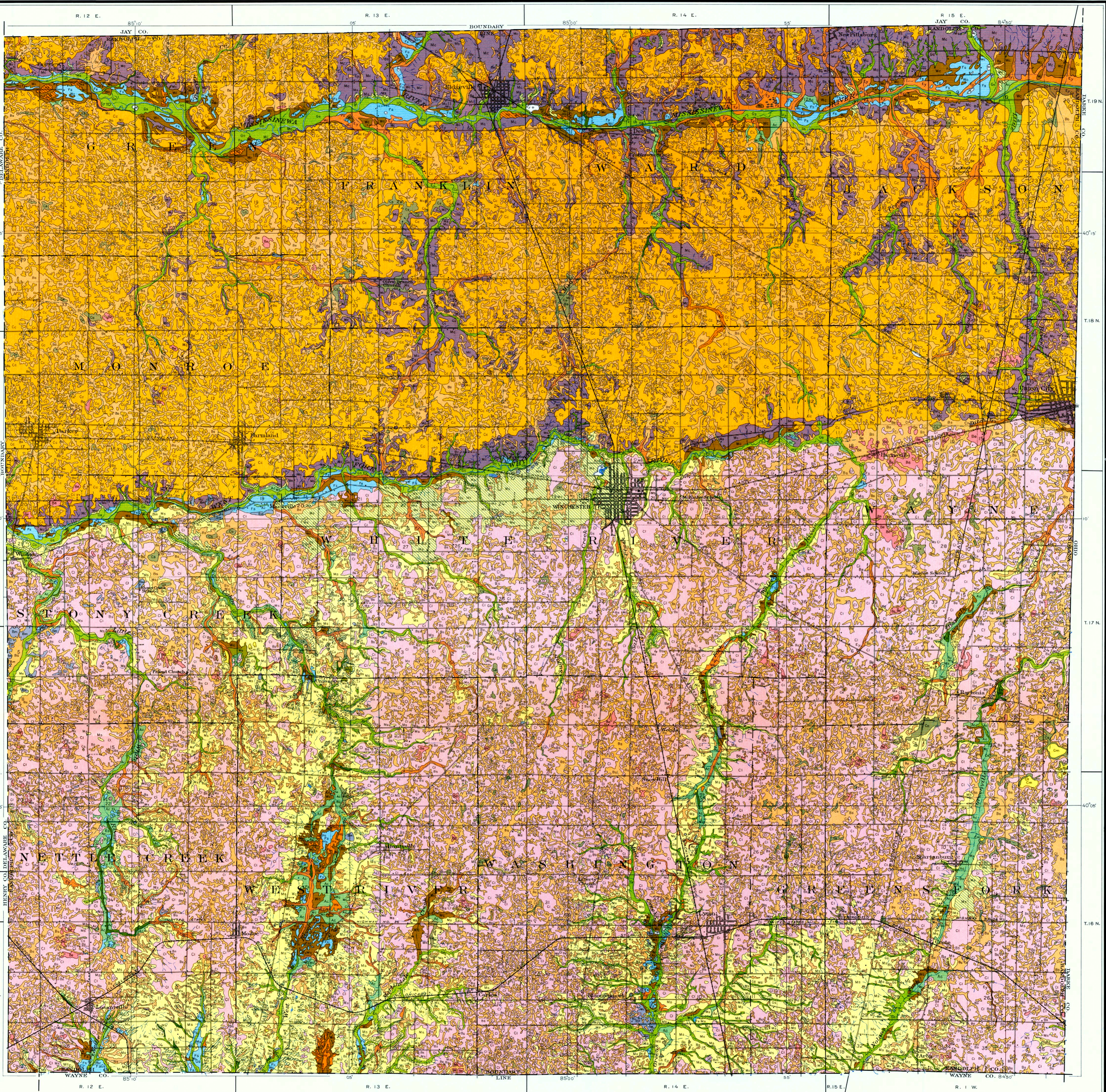
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LEGEND

Abington silty clay loam Ac	Genesee silt loam Gs
Bellefontaine silt loam Bm	Homer silt loam Hs
Bethel silt loam Be	Shallow phase
Brookston silty clay loam Bs	Miami silt loam Ms
Clyde silty clay loam Cs	Slope phase
Crosby silt loam Cl	Level phase
Crosby silty clay loam Cc	Miami silty clay loam Mc
Eel silt loam Es	Walkill silty clay loam Ws
Eel silty clay loam, Dark-colored phase Ey	Westland silty clay loam Wc
Fox silt loam Fs	Carlisle muck Cm
Gravel pit	

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.

Secondary roads and Trails

Bridges, Ferry

Ford, Dam

Mine or Quarry, Mine dumps, Made land

Stony and Gravelly areas

Boundary lines

CIVIL TOWNSHIP RESERVATION

Boundary lines

DOUBLE TRACKS, SINGLE TRACK, INTERSECTION, IS ROAD

R.R. ABOVE, R.R. BELOW

R.R. crossings, Tunnel

School or Church, Cemeteries

Bluff, Escarpment, Rock outcrop, Triangulation station

Soil boundaries

LAND GRANT, CITY OR VILLAGE

Boundary lines

U.S. township and section lines

DRAINAGE
(Printed in blue)

Streams

Lakes, Ponds, Intermittent lakes

Intermittent streams

Springs, Canals and Ditches, Flumes

Swamp, Salt marshes

Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.